

COW EVALUATION IN NORTH AMERICA

R.E. PEARSON and R.H. MILLER

United States Department of Agriculture, Agriculture Research Service, Animal Physiology and Genetics Institute, Beltsville, Md. 20705 (U.S.A.)

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ABSTRACT

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To date, cows have been evaluated both genetically and phenotypically primarily for milk and fat yield. For these traits, the estimation procedure is quite sophisticated. Although procedures in DHI computing centers vary considerably, many dairymen on test receive routine estimates of the producing and transmitting ability of their cows. The degree to which this information is used appears to be highly dependent upon the effectiveness of the extension education program in the particular state. The cow index calculated by the USDA has become the major criterion of selection for dams of young bulls.

Estimates of breeding values of cows for other traits are nearly nonexistent. As the economic importance of other traits is determined, procedures for obtaining data and for estimating breeding values will need to be developed.

Presently, culling guides are based mainly on current lactation production or on production on current test day. Little emphasis has been placed on projection of net returns.

INTRODUCTION

The purpose of this paper is to review cow evaluation practices that have been implemented in the United States and Canada. Two types of cow evaluation are needed by the dairy industry: (a) estimation of breeding values and (b) evaluation for cow culling. Cows to be dams of bulls for testing should be selected exclusively on their estimated genetic merit. The culling of females from the herd should be based upon the past and current phenotype of the cow as a predictor of future net returns (including the genetic value of the calf). Both aspects of cow evaluation will be discussed.

DATA COLLECTED

Milk and milk composition data in the United States are collected through local Dairy Herd Improvement (DHI) organizations and are processed through 11 dairy record processing centers. The cost of collecting the data

and the initial processing is borne totally by the dairymen on test. Each of the 11 centers calculates lactation milk and fat yield according to uniform national standards but is free to record other data as it sees fit. Estimated body weights, breeding dates, and to a lesser extent, screening test estimates of cell counts in milk and protein or solids-not-fat content are currently recordable by most of the computing centers. Dairymen are not, however, required to record these additional data. Uniform lactation milk and fat records are forwarded to the Animal Improvement Program Laboratory, ARS, USDA, Beltsville, Md. for sire and cow evaluation. This laboratory calculates estimated transmitting abilities for all identified cows and sires.

Conformational traits are observed by trained classifiers and results from these data are summarized by the respective breed-registry organizations. Each of the respective breed organizations uses different traits and carries out the program as it feels will be most useful to its members. Most of these data are collected on registered cows.

In addition, many of the artificial insemination (AI) units collect data on daughters of their sires. Traits collected by these units vary greatly and include stature, milking ease, temperament, udder characteristics and various type traits; similarly, methods of observation vary substantially. Some are dairymen's evaluation of their own cattle, and others are made by trained evaluators.

ESTIMATING BREEDING VALUES

Systematic estimation of the breeding values of cows in North America has been limited to milk and fat yield and an index of the two variables. Thus, virtually all of the advances in this area can be categorized as: (a) improved correction for environmental effects; (b) improvement in the sophistication and efficiency of the estimation procedure; and (c) inclusion of various relative groups in the estimation procedure. To a large extent, improvements in cow evaluation have paralleled the advances in sire evaluation although they have tended to lag slightly.

Deviating records from herdmates led to substantial improvements in estimation procedures in the U.S. during the 1960's. This type of comparison was initially used by USDA in sire proofs in the early 1960's; and in April 1964, the first national cow indexes were produced (King, 1973). For these indexes, selection index theory was used to weight the sire's regressed herd-mate deviation and the cow's herd-mate deviation (Miller, 1968). Initially, only the indexes for the top 2% of the registered cows of each breed were printed and distributed. The anticipated use of the list was in the selection of dams to produce bulls for testing. Currently, the cow index is used by the AI studs as the major selection criterion of bull dams.

In 1967, sire evaluation procedures used by USDA were changed in several ways (Plowman and McDaniel, 1968). These included accounting for the distribution of daughters across herds and the inclusion of the environmental

correlation (C^2) into the regression or repeatability term. These improvements changed the weights used to form the cow index but did not change the procedure.

The latest change made in the USDA—DHIA cow index was described by Powell et al. (1976). Again, this change accompanied a change in the sire summary. The new sire evaluation procedure (a) is a modified contemporary comparison in which modified contemporaries are adjusted for their sire's unregressed modified contemporary deviation (MCD), (b) improves the weighting procedure for forming the MCD, and (c) regresses the MCD to a group average based on the maternal grand sire and the sire of the bull (Dickinson et al., 1976). These new procedures allow for accurate comparisons of young and old bulls. The Predicted Difference (PD_{74}) of the sire and the MCD of the cow are weighted according to selection index theory to form the cow index. One additional change incorporated into the cow and sire evaluation at this time was the use of inprograss records. These records are a major help in obtaining estimates on cows while they are still in the herd and available for special matings. Also, estimates of breeding values of cows and sires are relative to a constant time under the new evaluation procedure. Currently, the indexes are calculated three times a year on all sire-identified cows and are distributed to the respective breed registry associations, AI studs, and DHI computing centers.

Additional research has been conducted considering the addition of the cow index of the dam of the cow. The dam's cow index will probably be added to the Cow Index calculation some time in the future and it will receive weight equal to that of the PD of the sire (R.L. Powell, personal communication, 1977).

The cow indexing procedure used by the Canadians at Guelph was described by Burnside (1970). It resembles the USDA system quite closely. The major differences are: (a) milk is expressed as a percentage of the Breed Class Average; (b) a true contemporary comparison is used; and (c) sire proofs currently included are estimated by best linear unbiased prediction (BLUP). Currently, plans are to implement an all-lactation BLUP procedure for cow indexing (E.B. Burnside, personal communication, 1977). This procedure is tentatively scheduled to be carried out at Ottawa. The effectiveness of the current pedigree index was recently reported by Stewart et al. (1976).

Several of the DHI computing centers also calculate estimated breeding values for cows for milk and fat. Generally, these values have been indexes based on herdmate deviations for various relative groups. The index calculated at Minnesota includes the cow's own records plus those of paternal half sibs; that at New York includes similar data plus the deviations for dam; and that at Iowa includes the three relative groups used by New York plus daughters and maternal half sisters across all herds (Eastwood, 1976). Currently, all herdmates in the Iowa system are being adjusted for their genetic level by subtracting twice the average herdmate's estimated average transmitting ability from the herdmate average. This is a single adjustment with

no iteration (Eastwood, 1976). Also, New York (R.W. Everett, personal communication, 1977) is in the planning stages of implementing a BLUP cow evaluation using the procedure described by Henderson (1975). This procedure will make use of all records of relatives within the herd plus records on paternal half sisters in other herds. In addition to estimated breeding values for cows, Iowa, North Carolina, and New York are presently including the estimated breeding values of each female calf on its individual calf pages or replacement heifer listing. In both cases, this is calculated as the sum of the estimated transmitting value of the sire and dam. North Carolina uses the cow index provided by USDA; Iowa uses its estimated average transmitting ability for the cow and USDA PD; and New York uses the results of its BLUP sire evaluation on first lactations and its estimated transmitting ability.

To date, perhaps the best empirical test of the effectiveness of estimating breeding values of sires and dams for pedigree selection was carried out at Iowa State (Freeman and Atkinson, 1973). Highest and lowest pedigree index heifers were purchased from a number of Iowa herds. On a within-herd-of-origin basis, deviations between high and low heifer's pedigree breeding values was 824 kg, and the difference in mature equivalent production was 839 kg.

In selection of bull dams, two additional problems have been identified and solutions proposed. In a study of the relationship of various pedigree information and son's progeny test, Butcher and Legates (1976), found that the correlation between dam's first record and son's progeny test tended to be consistently higher than the correlation involving later lactations. They suggested giving more weight to first lactations than later lactations in computing the cow index. Spike (1975) used data from the Iowa computing center to quantify the loss in expected genetic gain resulting from improperly accounting for genetic differences among herds. He found that adjusting herdmate records for the transmitting ability of the herdmates utilized 60% of the potential differences among herds. This change could increase genetic progress up to 10 kg per cow per year.

The degree of sophistication and the widespread effort applied to estimating breeding values for milk and fat for both sexes stand in contrast to the research and implementation applied to estimating breeding values for other traits, particularly for females. Recently, progress in sire evaluation for the conformation traits has been substantial (White et al., 1976); however, the most commonly used estimate of the cow's genotype for these traits is the actual score. Recently, one breed association recommended using the heritability times the deviation of the age adjusted score from the breed average as the estimate of breeding value (Kliewer, 1976). Although most breed associations now allow for lowering the cow's score, there is still an element of "best record" in these data. In no case is the average used. Thus, cow evaluation for conformation is based on a single phenotypic measurement. Hopefully, some form of index that includes all records of the cow

deviated from herdmates combined with paternal half sibs will be forthcoming.

For most other traits of dairy cattle, estimating the breeding value of females has not progressed past the stage of a single phenotypic measure uncorrected for environmental effects and ignoring the degree to which the trait is heritable. One of the major questions that faces dairy geneticists in the U.S. is what additional traits should be included in the selection process and what measures of these traits should be used (McDaniel, 1976; Pearson, 1976).

In choosing dams of young sires for testing, each stud has its own criteria. Although variation in the weights applied to various traits exists, most studs place substantial selection pressure on breeding value for milk, fat percentage, and conformation (Vinson and Freeman, 1972). Pedigree estimates for milk of young bulls entering studs currently average approximately 500 kg. However, much of the selection on conformation and, to a lesser extent, fat percentage is based on uncorrected phenotypic measures. Often this selection occurs as independent culling levels for these traits. In addition, cows with long calving intervals or with other traits considered to be deleterious are avoided.

FEMALE CULLING

Ideally, cow culling decisions should be based on future net returns. Actual milk yield and composition, value of calves, feed costs, labor and facilities costs per day, individual cow care costs, and cow depreciation should be included in future net returns (Pearson, 1974; Pearson and Freeman, 1973). Thus, one major question is, "What are the best predictors of future net returns?" Clearly, the milk producing ability of the cow will be the major contributor to the prediction. However, adjustment for current reproductive status could substantially improve the prediction of net return during the remainder of the current lactation and of the possible next lactation. Body weight is another possibly useful predictor, mainly through its influence of feed for maintenance and salvage value. Age or lactation number may be useful as a predictor of cow depreciation and individual cow care costs. Because of the scope of the variability in individual cow care costs from herd to herd, it may well be fruitless to develop estimators of these costs other than in the most simplistic ways. Projection of future net returns should be predicted from deviations around the herd mean for the various traits and should use parameters and prices supplied by the dairyman. This will help to remove some of the effects that are peculiar to a given herd.

Projection of net returns as a basis of culling was examined by Palmer (1975). The index developed for cow culling purposes covered the remainder of the current lactation and the first days of the next lactation and is expressed as dollars of net return per day. In the index he considered the number of days in the prediction period (D); the predicted value of milk pro-

duced in the next D days (M); the predicted value of the calf carried (C); and the predicted value of the feed to be consumed in the next D days (F). The index was calculated as $(M + C - F)/D$. Using simulated data, he also investigated the effect of variation in stage of lactation, months bred, parity, PD of the service sire, and the estimated producing ability of the cow on the index. Although Palmer's index is far more simplified than a theoretically more accurate predictor, it provides a good basis for implementing such a system into the DHI program. Also, it may account for a substantial amount of the explainable variation in future returns. The system does require, however, accurate reporting of breeding information. Because many herds are currently not accurately reporting all breeding information, printing the breeding information on which the index is based could serve as a useful and necessary check.

A rough approximation of how some dairymen make culling decisions was reported by Meadows (1976). He suggests that most culling decisions for production are made during first lactation and that the remainder of the culling is to remove cows that have become unprofitable.

Having discussed what might be ideal in the way of cow evaluation for culling, it seems desirable to survey what evaluations are available to dairymen through their DHI computing centers. Results of this survey are presented in Table I. Nearly all centers in the U.S. are providing some form of within-herd evaluation of current lactation production each month. These include deviations from herd mates, a letter grade indicating the quartile of the herd in which the record falls, and a relative value expressing the record as a percentage of the herd mate or contemporary average. In addition, estimated producing ability of the cow based on all her records is calculated either once or twice yearly by about one-half of the computing centers.

Approximately one-half of the centers calculate income over feed cost on test day and summed over the lactation to date, and one of the centers calculates the dollar value of milk expected in the 305-day lactation (Palmer, 1975). These values are printed each month as part of the DHI report.

The last category of culling aids provided to dairymen through the DHI program is optional management lists of low cows or potential culls. The basis of choosing the cows to appear on these lists varies from center to center (Table I). Agritech Analytics includes cows below some value of fat corrected milk (FCM) (supplied by the dairyman) on test day if they are less than 150 days pregnant. The Cornell University Center includes all cows with a current extended mature equivalent (ME) production more than 10% below the rolling herd average. The Iowa State center prepares two lists: the first includes the lowest cows based on the dairyman's option of herd mate deviation, daily production, 305 days/ $2 \times$ ME, or income over feed cost; the second is a comparison of cows based on current profitability, profit until due to calve, dollar difference from herd mates and total profitability. The North Carolina State list of "cows to consider for culling" includes cows for which the value of milk on test day is less than 60% of the rolling herd average value and for

TABLE I

Survey of culling aids calculated by the various DHI processing centers

Computing center	Expected 305 day	Within herd evaluation	Estimated pro- ducing ability	Culling guides
Agritech Analytics (Tulare, Calif.)	Monthly	Monthly	—	Less than "X" fat corrected milk; less than 150 days pregnant
Cornell University (Ithaca, New York)	Monthly	Monthly	Calculated $3 \times$ per year	Mature equivalent, extended record 10% below rolling herds average
Iowa State	Monthly	Monthly	Yearly	(a) Low cows — dairyman's option. (b) Low total profitability cows.
Michigan State	Monthly	—	—	
University of Minnesota	Monthly	Monthly	Yearly	
North Carolina State	Monthly	Monthly	Yearly	Estimated income over feed cost for remainder of current lactation 305 days into next lactation.
Pennsylvania State	Monthly	Monthly	Yearly	
DHI Computing Service (Provo, Utah)	Monthly	Monthly	—	Less than "X" milk and (a) relative lactation yield < 80% or (b) open or (c) California Mastitis Test = 3 or (d) open 21 days over dairymens goal and relative value < 90%
McDonald College (Quebec, Canada)	—	Monthly	—	
Agricultural Records Co-op (Madison, Wisc.)	Monthly	Monthly	Yearly	
Washington State	Monthly	Monthly	—	

which days until due is greater than "X". "X" decreases as the value of the cow's milk relative to the value of herd average production decreases. For each cow on the list, projected relative profit is calculated for the period between current test day and completion of the next 305-day lactation. The DHI Computing Service (Provo, Utah) lists cows less than "X" lb on test day (dairyman's option) that also meet one of four other criteria for reproduction, mastitis, or production. The projected relative profit of the North Carolina State center and the projected income over feed cost of Iowa State are the only examples of future projection of income which are currently being provided in the DHI program.

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RESUME

Pearson, R.E. et Miller, R.H., 1978. Evaluation des vaches en Amérique du Nord. *Livest. Prod. Sci.*, 5: 19—28 (en anglais).

Jusqu'ici on a évalué les vaches au plan génétique et phénotypique essentiellement pour la production de lait et de matières grasses, cela avec des méthodes d'estimation complexes. Bien que les méthodes utilisées dans les centres de calcul du DHIV varient de façon considérable, de nombreux producteurs laitiers reçoivent des estimations de routine de la capacité de production et de la valeur héréditaire de leurs vaches. Le degré d'utilisation de ces informations semble dépendre étroitement de l'efficacité des programmes de développement dans l'Etat considéré. L'index calculé par le Ministère de l'Agriculture est devenu le critère majeur du choix des mères à taureaux.

Il n'existe pratiquement pas d'estimation de la valeur génétique additive des vaches pour les autres caractères. Quand l'importance économique de ces derniers aura été déterminée, il faudra développer les méthodes correspondantes de collecte des données et d'estimation de la valeur héréditaire.

Pour le moment la réforme est basée principalement sur la production au cours de la lactation ou la production le jour du contrôle. On n'a guère mis l'accent sur le bénéfice net.

KURZFASSUNG

Pearson, R.E. und Miller, R.H., 1978. Zuchtwertschätzung von Kühen in Nord-Amerika. *Livest. Prod. Sci.*, 5: 19—28 (in Englisch).

Bisher wurde die genetische und phänotypische Bewertung von Kühen vorwiegend hinsichtlich Milch- und Fettleistung durchgeführt. Für diese Merkmale ist das Schätzverfahren ziemlich kompliziert. Es besteht eine erhebliche Variation zwischen den DHI Computer-Zentren. Viele Milchviehbesitzer erhalten routinemässige Schätzungen der Produktionseignung und Vererbungsfähigkeit ihrer Kühe. Der Umfang, in welchem diese Information verwendet wird, scheint in hohem Masse von der Effektivität des Ausbildungs- und Beratungsprogramms in den einzelnen Staaten abzuhängen. Der vom USDA errechnete Kuhindex ist zum wesentlichsten Kriterium für die Selektion der Mütter von Jungbullen geworden.

Zuchtwertschätzungen von Kühen hinsichtlich sonstiger Merkmale sind praktisch nicht vorhanden. Es wurde die ökonomische Bedeutung sonstiger Merkmale bestimmt. Es müssen nun noch Verfahren zur Datensammlung und für die Zuchtwertschätzung entwickelt werden.

Zur Zeit werden Empfehlungen zum Ausmerzen von Tieren überwiegend auf der Grundlage der laufenden Laktationsleistung oder aufgrund der Leistung während des üblichen Prüfungstages gegeben. Auf die Ermittlung des Reinertrages wurde bisher wenig Wert gelegt.